

- d) High brightness electron beam generation at the ANL:* In the past year, the AWA group began to develop and characterize high-brightness electron beam sources. This research fits well with our mission to study the beam dynamics of electron sources. In this particular work, we exercise a combination of theoretical analysis, numerical simulation, and experimental tools.

The AWA facility can be operated in a high-brightness mode when the photoelectron charge extracted from the Drive Gun is set to 1 nC. In this mode, PARMELA simulations have shown the facility capable of producing normalized transverse emittance of 1  $\mu\text{m}$ , bunch length of 700  $\mu\text{m}$ , and energy spread of 1% at a kinetic energy of 19 MeV. The recent activities at the AWA facility have focused on the development of innovative diagnostic experiments designed to characterize the beam operating in the high-brightness mode.

We performed beam dynamics studies for the space-charge dominated beam from the 1.5 cell drive gun. Measurements of the transverse beam envelope were made in the drift region located between 102 cm and 375 cm after the photocathode plane, for a beam with charge of 1 nC, energy of 8 MeV, and a bunch length of 800  $\mu\text{m}$ . The measurements of the beam envelope in the drift were in reasonably good agreement with the PARMELA predictions. We also developed and investigated the usefulness of a modified 3-screen emittance measurement method; using a model that included both space-charge and emittance effects. Contrary to the popular wisdom, we discovered that for beams so heavily space-charge dominated this technique did not have sufficient emittance resolution to constrain the emittance to within a useful range. However, we also observed that the modified 3-screen technique is still useful for measuring the emittance of a beam that is not so space-charge dominated, say when the space charge to emittance ratio ( $R$ )  $< 10$ . This work resulted in a publication submitted to Nuc. Instrum. Meth. A.

We also carried out a novel OTR interferometry (OTRI) experiment (in collaboration with R. Fiorito of U.M.D.) that, in addition to measuring the usual rms emittance, should also be capable of measuring the energy spread. This technique is necessary when measuring the emittance directly from a photoinjector due to the non-negligible energy spread. This technique is based on measuring the effects of all the parameters affecting the visibility of OTR interference fringes, such as energy spread, angular divergence, the ratio of foil separation to wavelength ratio,  $d/\lambda$  and the filter bandpass. The initial experiments were carried out in the Fall 2004, and subsequent analysis showed that a different foil spacing is needed for the AWA setup. Further experiments are planned for 2005.